MK 2200

User's Manual

Combined Overcurrent and Earth Fault Relay

MK2200 ver 2.1 -040413

NOTICE

About This Edition

The information in this guide applies to Model MK2200 Revision A. For continuous improvement, we reserve the right to supply equipment which may vary from that described in this manual without prior notice. Mikro shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

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CAUTION

This equipment shall be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Mikro for any consequences arising out of the use of this material.

This equipment is intended for indoor installation and use only. If outdoor installation is required, it must be mounted in housing having IP54 classification of degree of protection.

SAFETY AND WARNING INFORMATION

Please read this Safety and Warning Information carefully. This information is intended to ensure that the equipment is properly handled, installed, operated and maintained in a safe condition.

Symbols and Conventions Used in this Manual

	Shock hazard
	Caution – See operating instruction
	Protective earth (ground)
	Earth (Ground)

WARNING

Warning statements describe conditions or action that can result in personal injury or loss of life.

CAUTION

Caution statements describe conditions or actions that can result in property damage.

NOTE

Notes contain additional information on usage.

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Chapter 1: Introduction

MK2200 is a digital microprocessor based numerical combined overcurrent and earth fault relay. It employs extensive advanced numerical technique, implemented real-time, for the computation of fault currents and the execution of intended protection functions.

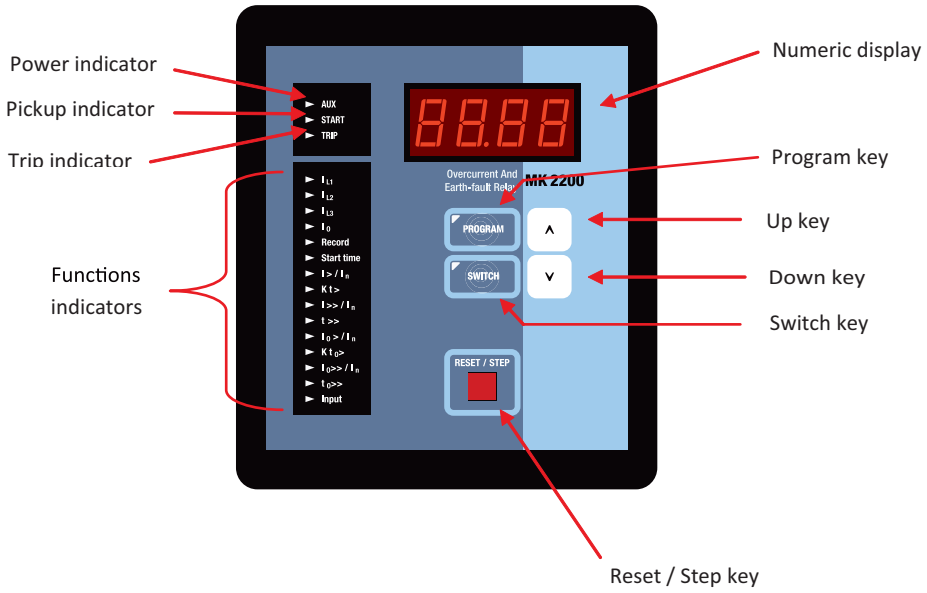


Figure 1.1: Front view of MK2200

MK2200 is housed in an aluminum case suitable for panel mounting. The transparent polycarbonate front panel cover provides IP54 degree of protection against splashing water besides acting as a sealed cover against tampering or unauthorised changes to the settings of the relay.

Fully digital user interface with large and bright seven-segment LED display, indicators and push button switches give a very user-friendly access to the status, settings and recorded information of the relay.

The relay can have up to 4 current transformer (CT) inputs with the CTs' ratio of either 5A or 1A. An optically isolated digital input can be programmed as changeover input for protection group settings, remote reset input, blocking input or external tripping input. Five programmable output contacts can response to relay pick-up and/or relay trip. In addition, a changeover IRF contact is available for monitoring any relay failure.

Through the optically isolated RS485 Modbus-RTU serial communication interface, MK2200 can be networked to SCADA system.

Chapter 2: Description of Operation

MK2200 consists of three independent phase overcurrent elements and one non-directional earth fault element. It is intended to be used for phase short circuit protection and earth fault protection of electrical distribution system. All the overcurrent and earth fault elements in the relay are connected to the electrical distribution feeders to be protected through either 5A CTs or 1A CTs as shown in Chapter 5. Measurements of the phase currents and earth fault current are done through waveform sampling and numerical technique to extract only the fundamental frequency components thus eliminate the possible erroneous response to protection function as a result of harmonic currents in the electrical distribution system.

2.1 Phase Overcurrent Protection [50/51]

The phase overcurrent protection consists of low-set stage and high-set stage for all the three phases namely, I_{L1}, I_{L2}, and I_{L3}. The low-set element setting and the high-set element setting are common to all the three phases. MK2200 provides dual setting groups, Group A or Group B, interchangeable through an external digital input configurable through Soft Switch A.

2.1.1 Low-set Overcurrent Element

During a fault condition, if the phase current exceeds the threshold of low-set overcurrent setting *I*>, the MK2200 generates a start signal to activate the output contacts R2 to R5, which are user programmable to response to the start signal from low-set overcurrent element through Soft Switches 2 to 5 respectively. Simultaneously, the START indicator on the relay panel light up to indicates that the relay picks up. After a delay time longer than the set *t*>, the MK2200 then generates a trip signal to activate the output contacts R2 to R5, which are user programmable to response to the trip signal from low-set overcurrent element through Soft Switch 2 to 5 respectively. The TRIP indicator blinks to indicate that the relay has tripped.

Depending on the Soft Switch 8 and Soft Switch 9 settings, the time delay between the start signal and trip signal can either be a fixed time delay or a variable time delay inversely proportional to the fault current. This variable time-current delay characteristic is in accordance with IEC 60255-3 standard for inverse definite minimum time (IDMT) curve.

2.1.2 High-set Overcurrent Element

If the phase current exceeds the threshold of high-set overcurrent setting *I*>>, the MK2200 generates a start signal to activate the output contacts R2 to R5, which are user programmable to response to the start signal from high-set overcurrent element through Soft Switches 2 to 5 respectively. Simultaneously, the START indicator on the relay panel light up to indicates that the relay picks up. After a delay time longer than the set *t*>>, the MK2200 then generates a trip signal to activate the output contacts R2 to R5, which are user programmable to response to the trip signal from high-set overcurrent element through Soft Switch 2 to 5 respectively. The TRIP indicator blinks to indicate that the relay has tripped. The time delay between the start signal and trip signal can either be instantaneous without any intentional delay or a fixed time delay settable through *t*>>.

NOTE This high -set element can be disabled through Soft Switch 1.

When the electrical power system is restored after a power outage or when a large motor load is started, the phase currents can momentarily increase by several times a condition known as cold load pick-up. This may cause unwanted tripping by the relay's high-set elements. However, if *I*>> is set too high to overcome cold load pick-up tripping, protection may be compromised. MK2200 allows user to automatically double the *I*>> setting when it detects a cold load pick-up condition.

A cold load pick-up condition starts when the phase current increases from below 0.12 times of the overcurrent low-set (*I*>) setting to 3 times *I*> within a time less than 60ms. This condition ends when the phase current fall below 2 times *I*>.

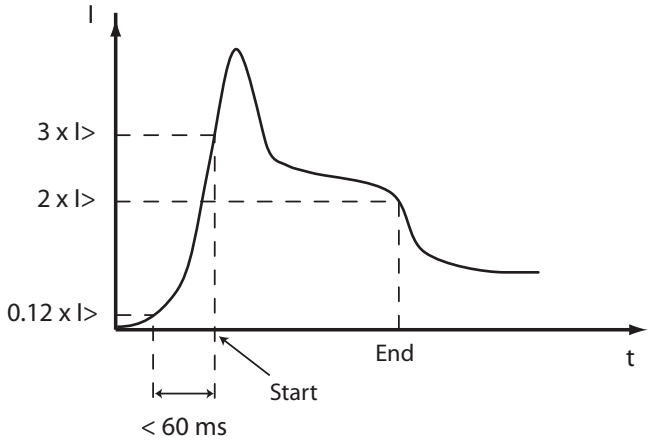


Figure 2.1: Cold load pick-up

2.2 Earth Fault Protection [50N/51N]

Earth fault protection elements comprise of one low-set stage and one high-set stage.

2.2.1 Low-set Earth Fault Element

During a fault condition, if the earth fault element exceeds the threshold of low-set earth fault setting I_o>, the MK2200 generates a start signal to activate the output contacts R2 to R5, which are user programmable to response to the start signal from low-set earth fault element through Soft Switches 2 to 5 respectively. Simultaneously, the START indicator on the relay panel light up to indicates that the relay picks up. After a delay time longer than the set t_o>, the MK2200 then generates a trip signal to activate the output contacts R2 to R5, which are user programmable to response to the trip signal from low-set earth fault element through Soft Switch 2 to 5 respectively. The TRIP indicator blinks to indicate that the relay has tripped.

Depending on the Soft Switch 8 and Soft Switch 9 settings, the time delay between the start signal and trip signal can either be a fixed time delay or a variable time delay inversely proportional to the fault current. This variable time current delay characteristic is in accordance with IEC 60255-3 standard for inverse definite minimum time (IDMT) curve.

2.2.2 High-set Earth Fault Element

If the earth fault exceeds the threshold of high-set earth fault setting I_o>>, the MK2200 generates a start signal to activate the output contacts R2 to R5, which are user programmable to response to the start signal from high-set earth fault element through Soft Switches 2 to 5 respectively. Simultaneously, the START indicator on the relay panel light up to indicates that the relay picks up. After a delay time longer that the set t_o>>, the MK2200 then generates a trip signal to activate the output contacts R2 to R5, which are user programmable to response to the trip signal from high-set earth fault element through Soft Switch 2 to 5 respectively. The TRIP indicator blinks to indicate that the relay has trip signal can either be instantaneous without any intentional delay or a fixed time delay settable through t_o>>.

NOTE

This high -set element can be disabled through Soft Switch 1.

2.3 Circuit Breaker Failure Protection [50BF]

MK2200 has an in-built circuit breaker failure protection (CBFP) function selectable through Soft Switch 1. If CBFP is selected, it generates a tripping signal via contact output R2 after a pre-set time delay as shown in Fig. 2.2 if the fault has not been cleared after the activation of tripping signal through contact output R1. The CBFP output R2 is usually used to trip the upstream circuit breaker or to trip a redundant tripping circuit of the same circuit breaker. The pre-set breaker failure timer [62] can be set between 120ms, 150ms or 200ms.

CAUTION

Since R2 is the dedicated CBFP output, Soft Switch 2 setting will be ignored if CBFP is s elected. If CBFP is selected for both Group A and Group B, Soft Switch 2 will not be accessible.

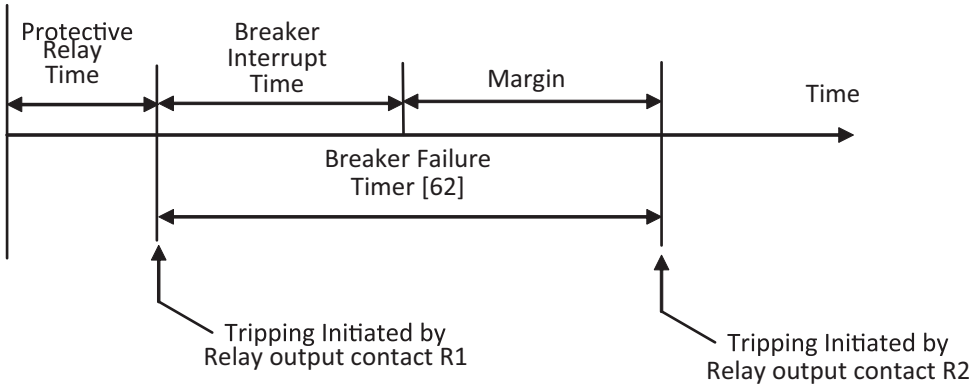


Figure 2.2: Timing diagram for CBFD.

2.4 Current Measurements

The three phase currents and the earth fault current are measured through either 5A or 1A CTs. The microprocessor in MK2200 samples the current waveforms at regular interval of 12 samples per cycle. Through digital filtering, only the fundamental frequency components (50Hz or 60Hz) are used for the protection functions. MK2200's metering feature allows all the phase currents and the earth fault current to be viewed through the front panel display or through the Modbus-RTU serial communication.

Make sure that the system frequency selection on Soft Switch F is set correctly. Failing to do so will result in erroneous reading of the phase and earth fault currents.

2.5 Digital Input

MK2200 has one optically isolated multifunction digital input which can be configured to perform one of the following functions through Soft Switch A:

- As blocking input for blocking the operation of one or more of the protection stages
- As group switching input to switch between Group A or Group B
- As remote reset input after relay tripped
- As external input for tripping the relay by activating output contact R1

When a DC or AC voltage within the specified range appears between the two terminals of the digital input, the digital input is activated.

This input can accept either DC or AC voltage up to 265VAC.

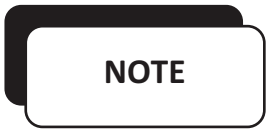
2.6 Programmable Output Contacts

MK2200 has five output contacts namely, R1, R2, R3, R4 & R5. Of all these output contacts, four are fully user programmable. R1 is factory preset to be the dedicated tripping contact and cannot be reprogrammed by the user. Relay tripping by any of the protection stages or by digital input, if selected, will activate the R1 output contact.

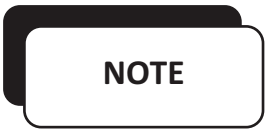
Output contacts R2, R3, R4 and R5 can be programmed to respond to any or all of the following events:

- Low-set overcurrent pick-up (start)
- Low-set earth fault pick-up (start)
- High-set overcurrent pick-up (start)
- High-set earth fault pick-up (start)
- Low-set overcurrent trip
- Low-set earth fault trip
- High-set overcurrent trip
- High-set earth fault trip

By programming Soft Switch 6, R2, R3, R4 and R5 can be configured for manual reset or auto reset after the contacts pick up. Similarly, Soft Switch 7 is used to configure R1, R2, R3, R4 and R5 for manual reset or auto reset after these contacts are activated by tripping signal.



Contact R1 response to tripping signal only and cannot be re-programmed. It is the default trip contact. However, it can be programmed to be a manually reset contact or an auto reset contact through Soft Switch 7.



Contact R2 is the default breaker failure protection output.

2.7 Internal Relay Failure (IRF) output

The IRF contact is a changeover contact. When the auxiliary power supply to the MK2200 is absent or the MK2200 relay malfunctions, the IRF relay will not operate indicating a fault condition. However, if the power supply to the MK2200 is switched on and it function normally, the IRF contact operates causing the normally-open (NO) contact to close and the normally-close (NC) contact to open.

2.8 Serial Communication

MK2200 is equipped with an optically isolated serial RS485 communication port running serial Modbus-RTU protocol. This allows the relay to be connected to a SCADA system for central monitoring purpose.

2.9 Time-Current Characteristic Curves

The low-set overcurrent element [51] and the low-set earth fault element [51N] can be independently programmed to have variable time delay proportional to the fault current in a manner prescribed by IEC standard IEC60255-3. These are called inverse definite minimum time (IDMT) curves. There are four available curve selections for MK2200:

- Normal inverse curve
- Very inverse curve
- Extremely inverse curve
- Long-time inverse curve

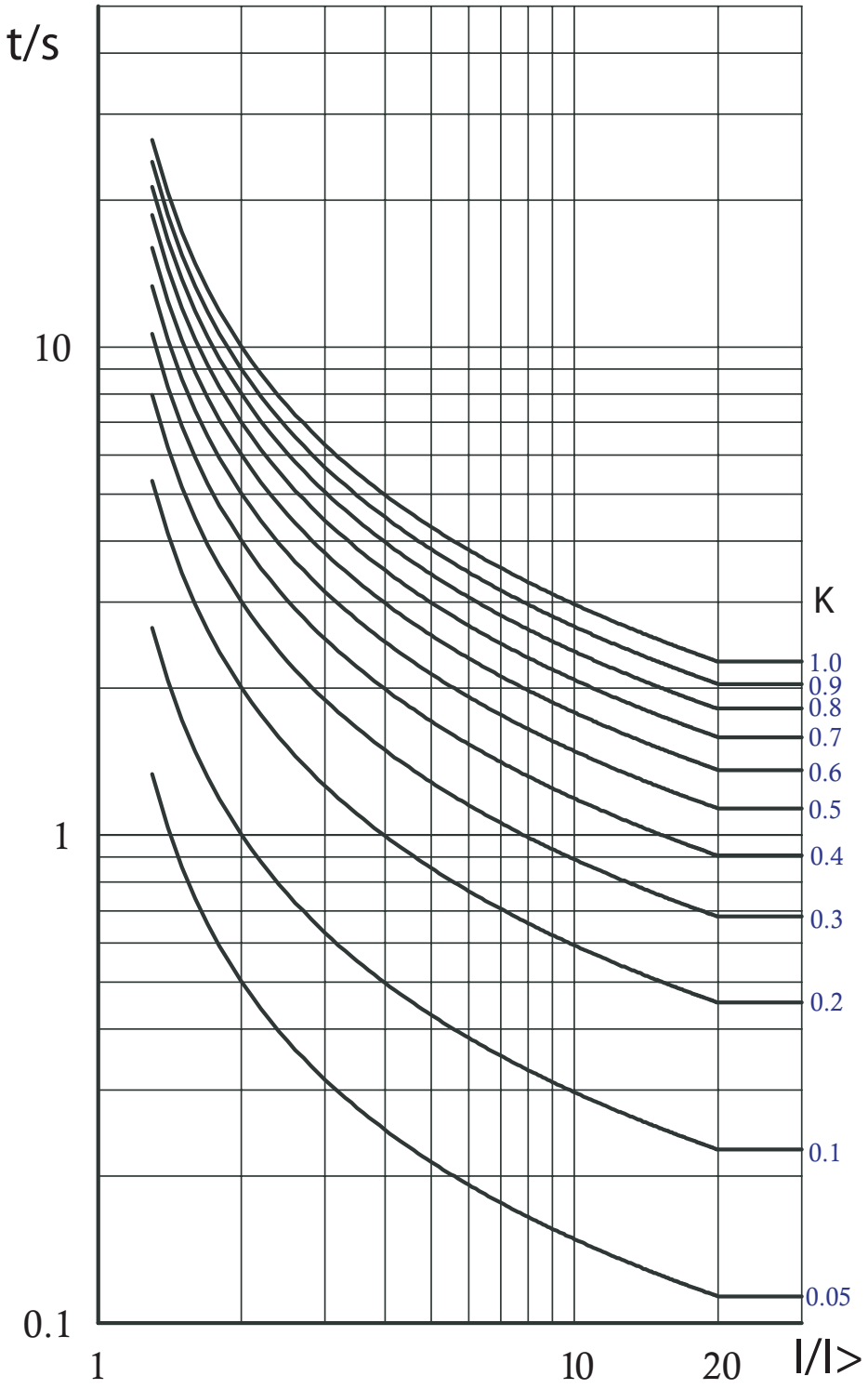
The equations for the above IDMT curves can be expressed as

$$t = \frac{K\beta}{(I/I>)^{\alpha} - 1}$$

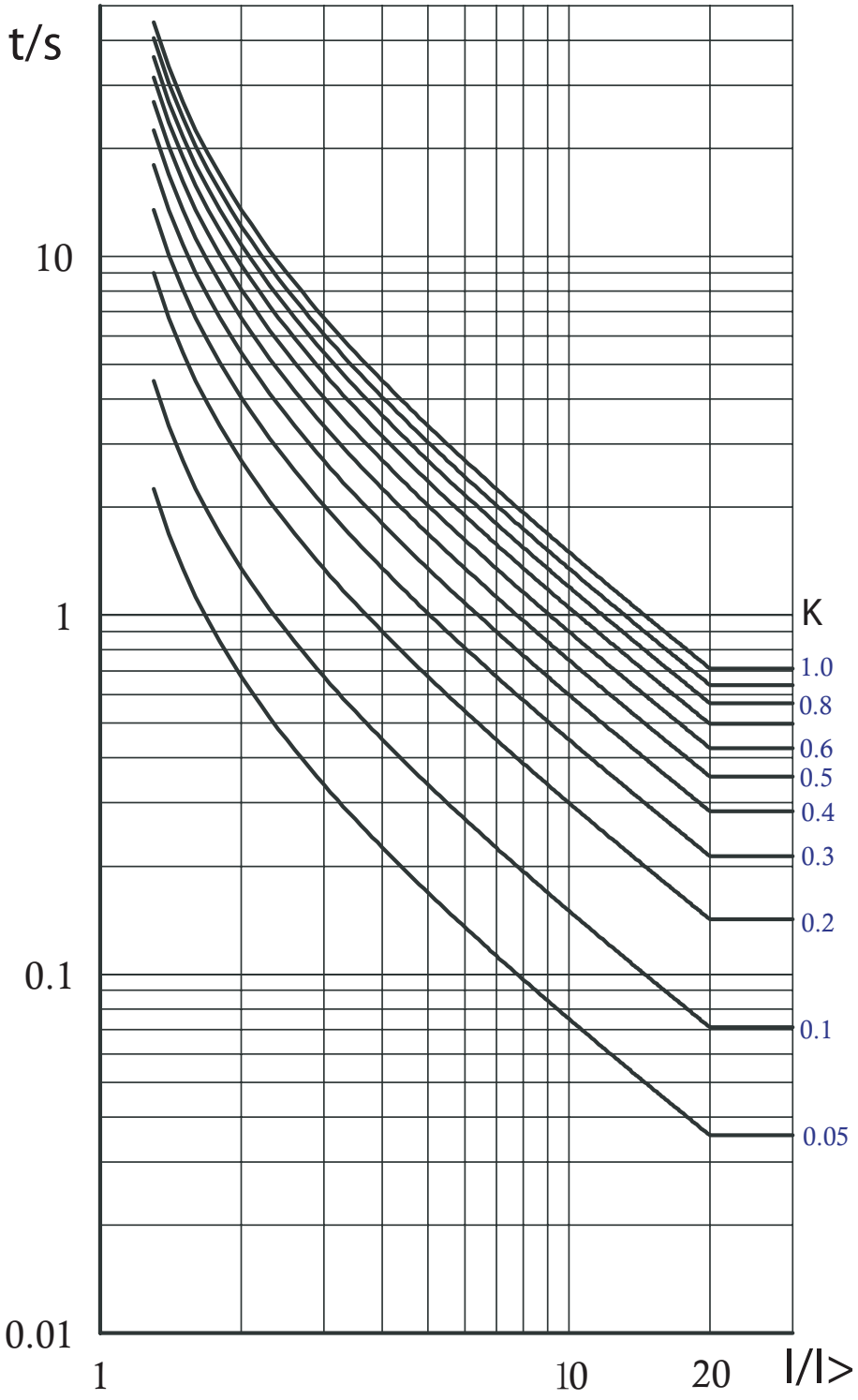
Where, t = operating time in seconds
K = time multiplier
I = measured current
I> = set current
α = constant
β = constant

Characteristic curve	α	β
Normal Inverse	0.02	0.14
Very Inverse	1.00	13.50
Extremely Inverse	2.00	80.00
Long -time Inverse	1.00	120.00

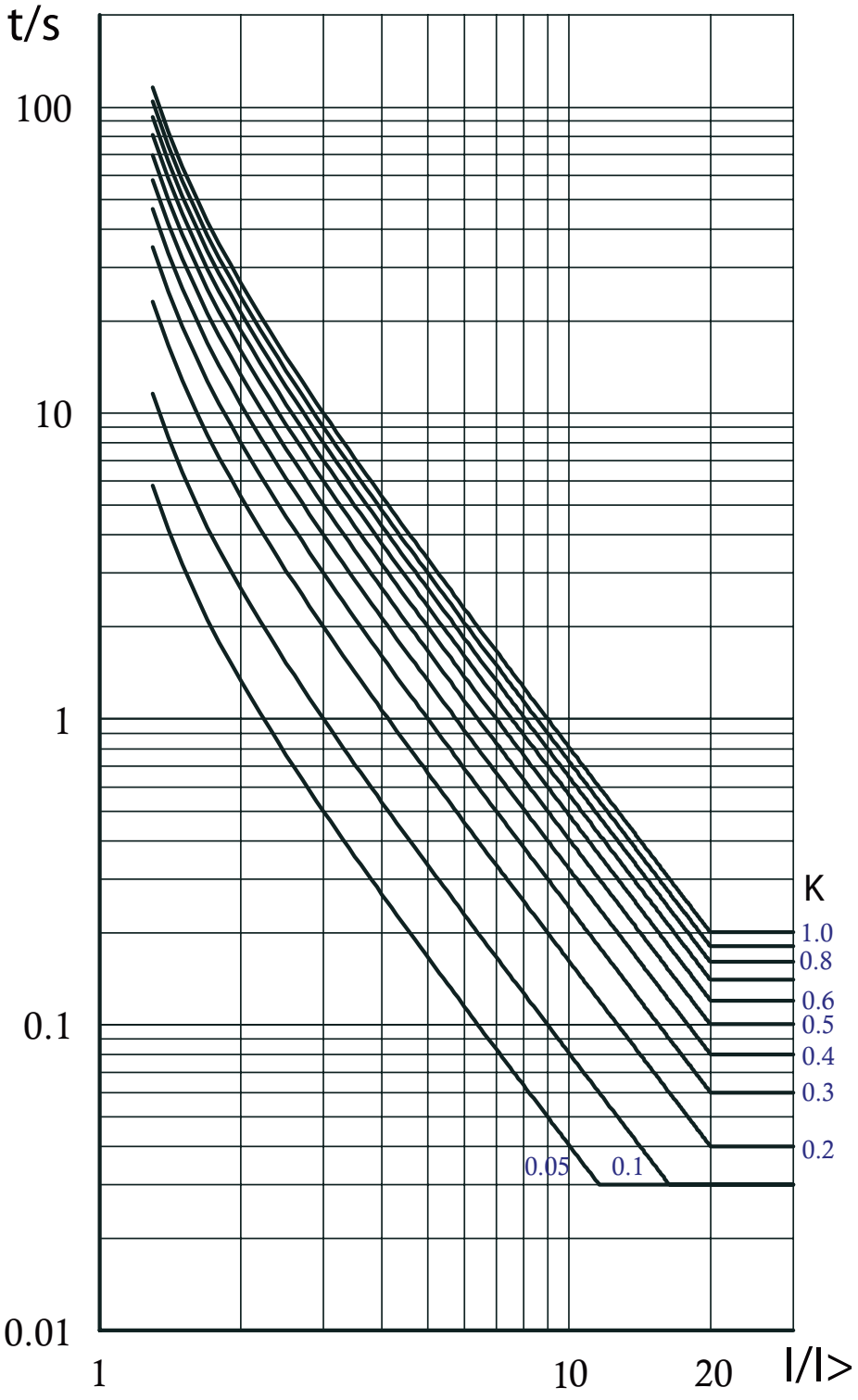
NORMAL INVERSE



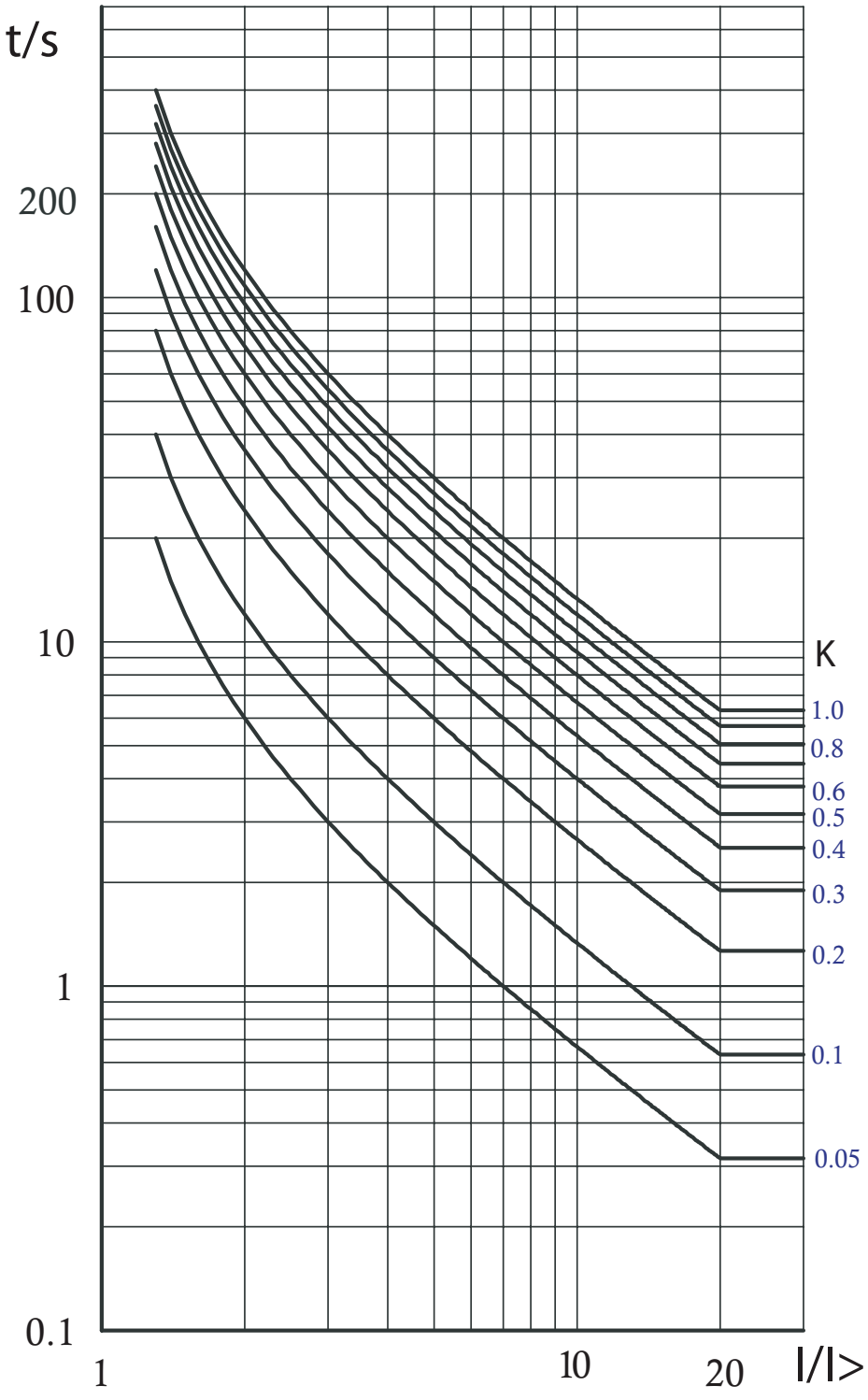
VERY INVERSE



EXTREMELY INVERSE



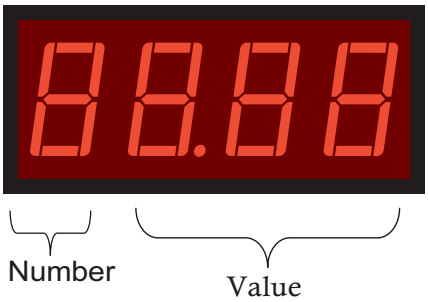
LONG-TIME INVERSE



Chapter 3: Display and User Programming

MK2200 has a very user friendly front panel interface. Item selected will have its indicator or indicators lighted up and the corresponding parameter for the selected item will be shown on a four-digit display.

3.1 Four-digit Display



The 4-digit display shows the parameter of the selected item. It can be divided into two sections. The left-most digit forms the first section which represents the number or group selection. The three right-most digit forms the second section which represents the value or setting.

3.2 Indicators

- ► **AUX**

  When lighted, it indicates the presence of auxiliary power supply to MK2200.

- ► **START**

  When any of the overcurrent or earth fault protection element pick-up /started, this indicator lights up. It turns off when all elements which started the pick-up are reset.

- ► **TRIP**

  When the relay trip due to tripping of any of the protection element; this indicator blinks to indicate a tripped condition.

- ► **I_{L1}**

  When this indicator is lighted, the 4-digit display shows the measured current for phase L1. If this indicator and the “Record” indicator light up simultaneously, the value shown on the 4-digit display is the recorded current for L1 at the moment of tripping.

- ► **I_{L2}**

  When this indicator is lighted, the 4-digit display shows the measured current for phase L2. If this indicator and the “Record” indicator light up simultaneously, the value shown on the 4-digit display is the recorded current for L2 at the moment of tripping.

- ► **I_{L3}**

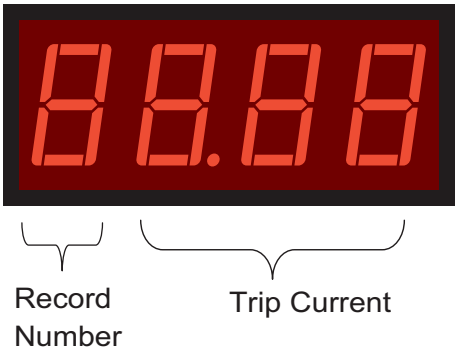
  When this indicator is lighted, the 4-digit display shows the measured current for phase L3. If this indicator and the “Record” indicator light up simultaneously, the value shown on the 4-digit display is the recorded current for L3 at the moment of tripping.

- ► **I_0**

  When this indicator is lighted, the 4-digit display shows the measured earth fault current L0. If this indicator and the “Record” indicator light up simultaneously, the value shown on the 4-digit display is the recorded earth fault current at the moment of tripping.

- ► **Record**

  This indicator lights up simultaneously with either indicators I_{L1}, I_{L2}, I_{L3} or indicator I_{LO}. When selected, the digit display shows the latest tripping fault current of the corresponding phases I_{L1}, I_{L2}, I_{L3} or I_{LO}.
  There are nine sets of trip records. To view all the records, press the UP or DOWN key. The left section of the four-digit display shows the record number and the right section of the four-digit display shows the trip current. Record 1 is the latest record.



NOTE

The fault current recorded is the current at the moment of relay tripping and not when the relay starts. The fault records are stored in non-volatile memory thus will not be erased even after the auxiliary power supply to the relay is switched off.

► Start time

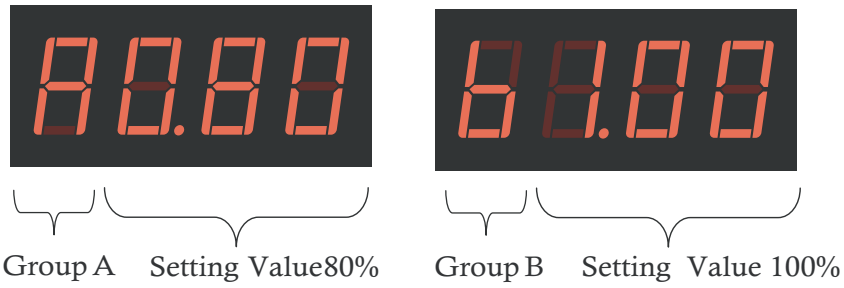
When this item is selected, the four-digit display shows the latest relay start time. This start time is the time period from relay pick-up until relay reset. The minimum record time is 0.1 second.

User can use this start timer to determine the duration of starting current for a heavy load such as a motor load or to check the total tripping time inclusive of breaker operating time. This timer will be overridden by a new start event or will be erased when the auxiliary power supply to the relay is switched off.

► I > / I n

When this item is selected, the four-digit display shows the low-set overcurrent setting of the relay. The left section of the four-digit display indicates whether the setting is for Group A or for Group B and the right section indicates the corresponding low-set overcurrent setting for either Group A or Group B. The overcurrent setting is expressed as ratio of $I_{setting}/I_{rated.}$

Examples:



► K t >

When this item is selected, depending on the settings of Soft Switch 8 and 9, the right section of the four-digit display shows either the low-set overcurrent time multiplier or the low-set overcurrent definite time delay. The left section of the four-digit display shows whether the selected setting is for Group A or for Group B.

When definite time delay is chosen; the unit of measurement is second.

- ► **$I >> / I_n$**

  When this item is selected, the four-digit display shows the high-set overcurrent setting of the relay. The left section of the four-digit display indicates whether the setting is for Group A or for Group B and the right section indicates the corresponding high-set overcurrent setting for either Group A or Group B. The overcurrent setting is expressed as ratio of $I_{setting}/I_{rated.}$

- ► **$t >>$**

  When this item is selected, the four-digit display shows the high-set overcurrent definite time delay. The left section of the four-digit display shows whether the selected setting is for Group A or for Group B. The unit of measurement is in second.

- ► **$I_0 > / I_n$**

  When this is selected, the four-digit display shows the low-set earth fault setting of the relay. The left section of the four-digit display indicates whether the setting is for Group A or for Group B and the right section indicates the corresponding low-set earth fault setting for either Group A or Group B. The earth fault setting is expressed as ratio of $I_{setting}/I_{rated}$.

- ► **$K t_0>$**

  When this item is selected, depending on the settings of Soft Switch 8 and 9, the right section of the four-digit display shows either the low-set earth fault time multiplier or the low-set earth fault definite time delay. The left section of the four-digit display shows whether the selected setting is for Group A or for Group B.

  When definite time delay is chosen; the unit of measurement is second.

- ► **$I_0>> / I_n$**

  When this item is selected, the four-digit display shows the high-set earth fault setting of the relay. The left section of the four-digit display indicates whether the setting is for Group A or for Group B and the right section indicates the corresponding high-set earth fault setting for either Group A or Group B. The earth fault setting is expressed as ratio of $I_{setting}/I_{rated.}$

- ► **$t_0>>$**

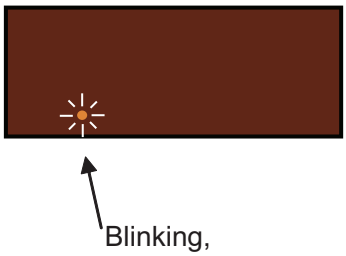
  When this item is selected, the four-digit display shows the high-set earth fault definite time delay. The left section of the four-digit display shows whether the selected setting is for Group A or for Group B. The unit of measurement is in second.

- ► **Input**

  This indicator mimic status of the digital input of MK2200A regardless of the Soft Switch A setting. This indicator lights up when the input is active (voltage source connected across Terminal 13 and Terminal 14).

3.3 Display under Normal Non-tripped Condition

When MK2200A is switched on, the AUX indicator lights up and a lamp test on the four-digit display is performed. After that, the decimal point on the left-most digit blinks indicating that the relay is functioning normally.



NOTE

If the relay was previously switched off after tripping without resetting, the display will resume the previous trip state during subsequent power up.

One or more of these indicators blinks to indicate the cause of tripping.

3.4 Display under Start Condition

When any of MK2200's protection elements pickup, the following indicators light up.

► **START** — This indicator shows the relay has started

► I_{L1}
► I_{L2}
► I_{L3}
► I_0

One or more of these indicators blinks to indicate the cause of starting.

3.5 Display under Trip Condition

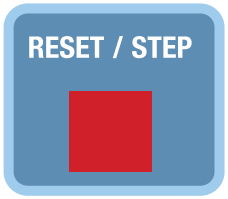
When MK2200 trips; the following indicators light up.

- TRIP — This indicator shows the relay tripped
- I_{L1}
- I_{L2}
- I_{L3}
- I_0

One or more of these indicators blinks to indicate the cause of tripping.

Blinking display indicates the tripping current

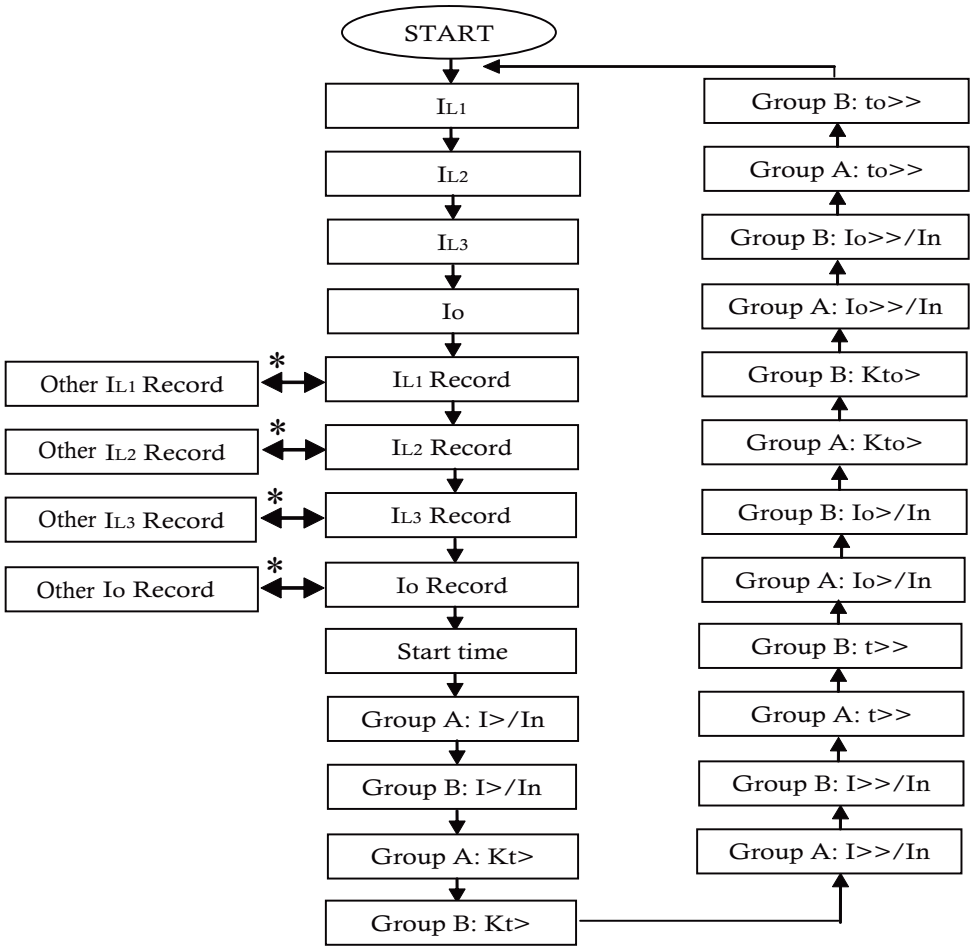
3.6 The RESET/STEP Key



This key has the following three functions:

a. To reset the relay when tripped.
b. To reset the output contacts which are configured to response to relay start and as manually reset contacts.
c. Function selection when the relay is in non-trip conditions.

The sequence of function selection by pressing the Reset/Step key is as the flow diagram below.



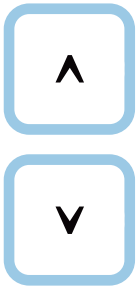
* Use UP or DOWN key

Figure 3.1: The sequence of function selection

3.7 The PROGRAM Key

Once the desired function or Soft Switch has been selected by the STEP key or the SWITCH key and the selected item is programmable, pressing the PROGRAM key enables the programming mode for the selected item. The value or setting of the selected item can then be changed by pressing the UP or DOWN key. Pressing the PROGRAM key again while in the programming mode will cause the relay to exit the programming mode with the new value or setting saved into a non-volatile memory.

3.8 The UP and DOWN Keys



When in programming mode, pressing these keys change the value or setting of the selected item. MK2200 has a maximum of nine fault records. If the UP or DOWN key is pressed when viewing these records, it move to the previous or next record respectively.

NOTE

Press and hold these keys allow fast changing of the value or setting.

3.9 The SWITCH Key

Pressing this SWITCH key allows the selection the Soft Switches by the user.

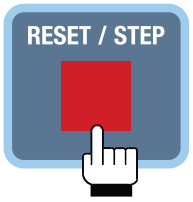
3.10 Programming the Protection Functions

The following steps are for the programming of

- Low-set overcurrent I>
- Low-set time multiplier/ time delay K t>
- High-set overcurrent I>>
- High-set time delay t>>
- Low-set earth fault Io>
- Low-set time multiplier/ time delay K to>
- High-set earth fault Io>>
- High-set time delay to>>

Step 1

Select the function to be programmed by repeatedly pressing the STEP key. The corresponding function indicator lights up.

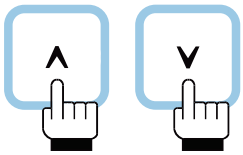


Step 2

Press the PROGRAM key once and the indicator adjacent to the PROGRAM key lights up. This indicates that the relay is now in programming mode. Simultaneously, one of the function indicators blinks to indicate that the particular function is selected for programming.

Step 3

Use the UP or DOWN key to select the desire value.



Step 4

To save the selected modified value, press the PROGRAM key once. The light indicator adjacent to the PROGRAM key turns off and the selected function indicator stops blinking.

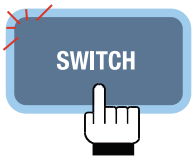
To abort without saving the modified value, press the STEP key.

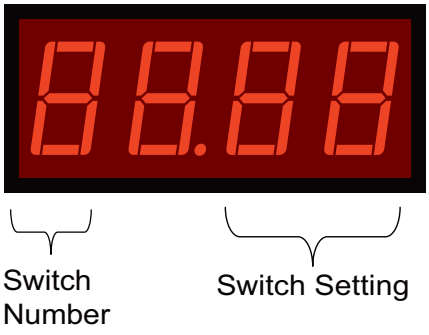
3.11 Programming the Soft Switches

The following steps are for programming the Soft Switches.

Step 1

Press the SWITCH ke y and the light indicator adjacent to the SWITCH key lights up. Repeatedly pressing the SWITCH key until the desired switch number appears on the display.



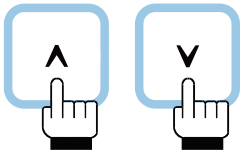


Step 2

Press the PROGRAM key once and the indicator adjacent to the PROGRAM key lights up. This indicates that the relay is now in programming mode for Soft Switches. The blinking switch number on the four-digit display indicates the Soft Switch selected.

Step 3

Use the UP or DOWN key to select the desire value.



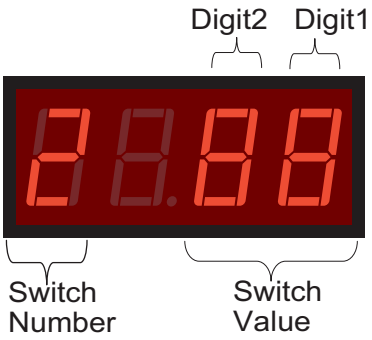
Step 4

To save the modified Soft Switch, press the PROGRAM key once. The light indicator adjacent to the PROGRAM key turns off and the switch number stops blinking.

To abort without saving the modified value, press the STEP key or the SWITCH key.

Chapter 4: Soft Switches

This Chapter describes the functions of all the Soft Switches. The following convention is used for the descriptions.



Soft Switches are used for the following functions:

- To set system frequency (60Hz or 50Hz)
- To configure MK2200's output contacts R1, R2, R3, R4 and R5
- To configure the IDMT characteristic curves for low-set overcurrent and earth fault
- To disable the high-set overcurrent and earth fault
- To enable Circuit Breaker Failure Protection function
- To configure the digital input
- To configure Modbus-RTU serial communication

Soft Switch 1

This Soft switch is for enabling or disabling the high-set elements of overcurrent and earth fault for Group A and Group B protection settings. In addition, it also allows the enabling and delay selection of CBFP [50BF] protection function. Refer to Chapter 2 for details on CBFP.

Soft Switch 1

	S1.7	S1.6	S1.5	S1.4	S1.3	S1.2	S1.1	S1.0
Remarks	CBFP (A)	CBFP (A)	Io>> (B)	Io>> (A)	CBFP (B)	CBFP (B)	I>> (B)	I>> (A)
Default setting (Binary)	0	0	1	1	0	0	1	1
Default setting (Hexadecimal)	3 (Digit 2)				3 (Digit 1)			
User's setting (Binary)								
User's setting (Hexadecimal)								

S1.0
This switch is for selection of overcurrent high-set for Group A

1 = overcurrent high-set enabled
0 = overcurrent high-set disabled

S1.1
This switch is for selection of overcurrent high-set for Group B

1 = overcurrent high-set enabled
0 = overcurrent high-set disabled

S1.4
This switch is for selection of earth fault high-set for Group A

1 = earth fault high-set enabled
0 = earth fault high-set disabled

S1.5
This switch is for selection of earth fault high-set for Group B

1 = earth fault high-set enabled
0 = earth fault high-set disabled

S1.6/S1.7 and **S1.2/s1.3** are switches for selection of breaker failure protection (50BF) function for Group A and Group B respectively. The selection is as shown in the table below:

50BF for Group A selection	S1.7	S1.6
Disabled	0	0
120 mS delay [62]	0	1
150 mS delay [62]	1	0
200 mS delay [62]	1	1

50BF for Group B selection	S1.3	S1.2
Disabled	0	0
120 mS delay [62]	0	1
150 mS delay [62]	1	0
200 mS delay [62]	1	1

CAUTION

Once the Breaker Failure Protection is selected, Relay R2 will be the dedicated breaker failure output tripping contact for backup breaker. All settings in relation to R2 on Soft Switch 2 will be ignored.

Soft Switch 2 to 5

Soft Switches 2 to 5 are used to configure the functional characteristic of contact output R2, R3, R4 and R5 respectively. Through these four Soft Switches, the corresponding contact outputs can be configured to response to one or more events such as relay start (pickup) and relay trip generated by any of the overcurrent or earth fault protection elements.

Table below shows the general setting option for contact output Rx and Soft Switch x.

	Sx.7	Sx.6	Sx.5	Sx.4	Sx.3	Sx.2	Sx.1	Sx.0
Remarks	Io>> trip	Io>> start	Io> trip	Io> start	I>> trip	I>> start	I> trip	I> start
Default setting (Binary)								
Default setting (Hexadecimal)	(Digit 2)				(Digit 1)			
User's setting (Binary)								
User's setting (Hexadecimal)								

Sx.0
This switch relates the relay output Rx to *low-set overcurrent start* signal

1 = Rx responding to low-set overcurrent start signal
0 = Rx not responding to low-set overcurrent start signal

Sx.1
This switch relates the relay output Rx to *low-set overcurrent trip* signal

1 = Rx responding to low-set overcurrent trip signal
0 = Rx not responding to low-set overcurrent trip signal

Sx.2
This switch relates the relay output Rx to *high-set overcurrent start* signal

1 = Rx responding to high-set overcurrent start signal
0 = Rx not responding to high-set overcurrent start signal

Sx.3
This switch relates the relay output Rx to *high-set overcurrent trip* signal

1 = Rx responding to high-set overcurrent trip signal
0 = Rx not responding to high-set overcurrent trip signal

Sx.4

This switch relates the relay output Rx to *low-set earth fault start* signal

1 = Rx responding to low-set earth fault start signal
0 = Rx not responding to low-set earth fault start signal

Sx.5

This switch relates the relay output Rx to *low-set earth fault trip* signal

1 = Rx responding to low-set earth fault trip signal
0 = Rx not responding to low-set earth fault trip signal

Sx.6

This switch relates the relay output Rx to *high-set earth fault start* signal

1 = Rx responding to high-set earth fault start signal
0 = Rx not responding to high-set earth fault start signal

Sx.7

This switch relates the relay output Rx to *high-set earth fault trip* signal

1 = Rx responding to high-set earth fault trip signal
0 = Rx not responding to high-set earth fault trip signal

Soft Switch 2

	S2.7	S2.6	S2.5	S2.4	S2.3	S2.2	S2.1	S2.0
Remarks	Io>> trip	Io>> start	Io> trip	Io> start	I>> trip	I>> start	I> trip	I> start
Default setting (Binary)	0	0	0	0	0	0	0	
Default setting (Hexadecimal)	0				0			
User's setting (Binary)								
User's setting (Hexadecimal)								

Soft Switch 3

	S3.7	S3.6	S3.5	S3.4	S3.3	S3.2	S3.1	S3.0
Remarks	Io>> trip	Io>> start	Io> trip	Io> start	I>> trip	I>> start	I> trip	I> start
Default setting (Binary)	0	0	0	0	0	0	0	1
Default setting (Hexadecimal)	0				1			
User's setting (Binary)								
User's setting (Hexadecimal)								

Soft Switch 4

	S4.7	S4.6	S4.5	S4.4	S4.3	S4.2	S4.1	S4.0
Remarks	Io>> trip	Io>> start	Io> trip	Io> start	I>> trip	I>> start	I> trip	I> start
Default setting (Binary)	0	0	0	0	1	0	1	0
Default setting (Hexadecimal)	0				A			
User's setting (Binary)								
User's setting (Hexadecimal)								

Soft Switch 5

	S5.7	S5.6	S5.5	S5.4	S5.3	S5.2	S5.1	S5.0
Remarks	Io>> trip	Io>> start	Io> trip	Io> start	I>> trip	I>> start	I> trip	I> start
Default setting (Binary)	1	0	1	0	0	0	0	0
Default setting (Hexadecimal)	A				0			
User's setting (Binary)								
User's setting (Hexadecimal)								

CAUTION

Output contact R1 is the default trip contact and cannot be re-programmed.

Soft Switch 6

Soft Switch 6 configures the output contacts R1, R2, R3, R4 & R5 to be latching type or non-latching type of contact when responding to a start signal.

Soft Switch 6

	S6.7	S6.6	S6.5	S6.4	S6.3	S6.2	S6.1	S6.0
Remarks	Not used	Not used	Not used	R5	R4	R3	R2	R1
Default setting (Binary)	0	0	0	0	0	0	0	0
Default setting (Hexadecimal)	0				0			
User's setting (Binary)	0	0	0					
User's setting (Hexadecimal)								

S6.0

This switch determines the contact type for R1 when responding to start signal

1 = Manual reset for R1 when responding to a start signal
0 = Auto reset for R1 when responding to a start signal

S6.1

This switch determines the contact type for R2 when responding to start signal

1 = Manual reset for R2 when responding to a start signal
0 = Auto reset for R2 when responding to a start signal

S6.2

This switch determines the contact type for R3 when responding to start signal

1 = Manual reset for R3 when responding to a start signal
0 = Auto reset for R3 when responding to a start signal

S6.3

This switch determines the contact type for R4 when responding to start signal

1 = Manual reset for R4 when responding to a start signal
0 = Auto reset for R4 when responding to a start signal

S6.4

This switch determines the contact type for R5 when responding to start signal

1 = Manual reset for R5 when responding to a start signal
0 = Auto reset for R5 when responding to a start signal

S6.5 to S6.7

Not used.

Soft Switch 7

Soft Switch 7 configures the output contacts R1, R2, R3, R4 & R5 to be latching type or non-latching type of contact when responding to a trip signal.

Soft Switch 7

	S7.7	S7.6	S7.5	S7.4	S7.3	S7.2	S7.1	S7.0
Remarks	Not used	Not used	Not used	R5	R4	R3	R2	R1
Default setting (Binary)	0	0	0	1	1	0	0	0
Default setting (Hexadecimal)	1				8			
User's setting (Binary)	0	0	0					
User's setting (Hexadecimal)								

S7.0

This switch determines the contact type for R1 when responding to trip signal

1 = Manual reset for R1 when responding to a trip signal
0 = Auto reset for R1 when responding to a trip signal

S7.1

This switch determines the contact type for R2 when responding to trip signal

1 = Manual reset for R2 when responding to a trip signal
0 = Auto reset for R2 when responding to a trip signal

S7.2

This switch determines the contact type for R3 when responding to trip signal

1 = Manual reset for R3 when responding to a trip signal
0 = Auto reset for R3 when responding to a trip signal

S7.3

This switch determines the contact type for R4 when responding to trip signal

1 = Manual reset for R4 when responding to a trip signal
0 = Auto reset for R4 when responding to a trip signal

S7.4

This switch determines the contact type for R5 when responding to trip signal

1 = Manual reset for R5 when responding to a trip signal
0 = Auto reset for R5 when responding to a trip signal

S7.5 to S7.7

Not used.

Soft Switch 8

This switch is Group A's selection of IDMT curves for low-set overcurrent and low-set earth fault.

	Digit 2	Digit 1
Remarks	K t> (Group A)	K to> (Group A)
Default setting	1	1
User's setting		

Digit 1 is for configuring the time-current characteristic curve of low-set earth fault element.

Time-current characteristic for earth fault	Setting
Normal inverse	1
Very inverse	2
Extremely inverse	3
Long-time inverse	4
Definite time	5

Digit 2 is for configuring the time-current characteristic curve of low-set overcurrent element.

Time-current characteristic for overcurrent	Setting
Normal inverse	1
Very inverse	2
Extremely inverse	3
Long-time inverse	4
Definite time	5

Soft Switch 9

This switch is Group B's selection of IDMT curves for low-set overcurrent and low-set earth fault.

	Digit 2	Digit 1
Remarks	K t> (Group B)	K to> (Group B)
Default setting	1	1
User's setting		

Digit 1 is for configuring the time-current characteristic curve of low-set earth fault element.

Time-current characteristic for earth fault	Setting
Normal inverse	1
Very inverse	2
Extremely inverse	3
Long-time inverse	4
Definite time	5

Digit 2 is for configuring the time-current characteristic curve of low-set overcurrent element.

Time-current characteristic for overcurrent	Setting
Normal inverse	1
Very inverse	2
Extremely inverse	3
Long-time inverse	4
Definite time	5

Soft Switch A

The digital input of MK2200 can be used for several functions and its intended function is determined by the setting of Soft Switch A. The available functions for the digital input are as shown below and only one function can be selected at any one time.

- Input for switching the protection settings between Group A and Group B
- Input for blocking the selected overcurrent and earth fault protection elements
- Input for remotely resetting a trip relay or resetting manual start contacts
- Input for tripping the MK2200 by another external device.

Besides being used for configuration of the digital input, switch SA.7 enable the automatic doubling of high-set overcurrent setting during a cold load pickup. Cold load pickup is started when the phase current increases from below 0.12 times of the low-set overcurrent setting to 3 times the low-set overcurrent setting in less than 60ms. This condition ends when the phase current fall below 2 times the low-set overcurrent setting.

Soft Switch A

	SA.7	SA.6	SA.5	SA.4	SA.3	SA.2	SA.1	SA.0
Remarks	CLP	Trip	Reset	Switch Group	Block I>>	Block I>	Block Io>>	Block Io>
Default setting (Binary)	0	0	0	0	0	0	0	0
Default setting (Hexadecimal)	0				0			
User's setting (Binary)								
User's setting (Hexadecimal)								

SA.0

When selected, this switch blocks the *low-set earth fault* element from operation

1 = Enable the blocking function
0 = Disable the blocking function

SA.1

When selected, this switch blocks the *high-set earth fault* element from operation

1 = Enable the blocking function
0 = Disable the blocking function

SA.2
When selected, this switch blocks the *low-set overcurrent* element from operation

1 = Enable the blocking function
0 = Disable the blocking function

SA.3
When selected, this switch blocks the *high-set overcurrent* element from operation

1 = Enable the blocking function
0 = Disable the blocking function

SA.4
When selected, the digital input switches the protection settings between Group A and Group B. If the digital input is in the ON state, Group B settings is selected otherwise Group A settings is selected. The digital input is in the ON stage if appropriate voltage appears between the two input terminals.

1 = Enable the group switching function
0 = Disable the group switching function

SA.5
When selected, the digital input becomes the remote reset input for MK2200 when MK2200 trips.

1 = Enable remote reset function
0 = Disable remote reset function

SA.6
When selected, an active digital input initiates a tripping causing only the output contact R1 of MK2200 to be activated. This input is for any external device to trip the relay.

1 = Enable external tripping function
0 = Disable external tripping function

SA.7
When selected, the high-set overcurrent setting automatically doubled during a cold load pickup.
Refer to Chapter 2 on details of cold load pickup.

1 = Enable the cold load pickup function
0 = Disable the cold load pickup function

Soft Switch B

This Soft Switch set the serial communication format for MK2200. It configures the data format and baud rate for the Modbus communication between host computer (client) and MK2200 (server).

	Digit 2	Digit 1
Default setting	4	7
User's setting		

Digit 1 is for selection of communication baud rate.

Baud rate	Digit 1 setting
300	1
600	2
1200	3
2400	4
4800	5
9600	6
19200	7

Digit 2 is for selection of data format.

Data format	Digit 2 setting
1 start bit, 8 data bits, no parity, 1 stop bit	1
1 start bit, 8 data bits, no parity, 2 stop bit	2
1 start bit, 8 data bits, odd parity, 1 stop bit	3
1 start bit, 8 data bits, even parity, 1 stop bit	4

Soft Switch C

Every Modbus device on a network is identified by a unique device's unit number. This Soft Switch is for configuring the unit number for MK2200. The setting range for MK2200's unit number is from 1 to 127 and it is displayed in hexadecimal format. Example, if the intended unit number is 42, then the display shows the equivalent hexadecimal value of 2A. Please refer to Appendix B for conversion between decimal number and hexadecimal number.

	Unit number setting
Default setting	1
User's setting	

Soft Switch D

The settings of MK2200 can either be changed through the front panel or through the serial Modbus-RTU communication. However, programming of settings by remote serial Modbus-RTU communication can be disabled by using this Soft Switch to prevent unauthorised or inadvertent change of relay's settings.

	Setting
Default setting	0
User's setting	

1 = Remote programming enabled
0 = Remote programming disabled

Soft switch E

This Soft Switch provides a mean for the user to manually turn on or turn off the relay's output contacts. This is very useful during testing and commissioning of the relay. During the test, one of the relay's output contacts can be switched on sequentially. Upon exiting the test, all output contacts will be switched off regardless of their state prior to the test.

Description	Display value
OFF all output contacts	00
ON output contact R1 only	01
ON output contact R2 only	02
ON output contact R3 only	03
ON output contact R4 only	04
ON output contact R5 only	05

Steps to switch the output contacts:

1. Select Soft Switch E by repeatedly pressing the SWITCH key
2. Press PROGRAM key and the Switch Number 'E' flashing
3. Press the UP or DOWN key to change the displayed value and the corresponding output contact will be switched on
4. To exit the test, press the SWITCH or PROGRAM key

NOTE

All output contacts will be switched off after the test irrespective of their previous state.

Soft Switch F

This Soft Switch is for selecting the operation frequency of the electrical system to be protected.

	Setting
Default setting	0 (50Hz)
User's setting	

1 = 60 Hz system frequency
0 = 50 Hz system frequency

CAUTION

System frequency must be set correctly before commissioning. Failure to do so will result in erroneous phase and earth fault current measurements.

Chapter 5: Connection

5.1 Connection Terminals

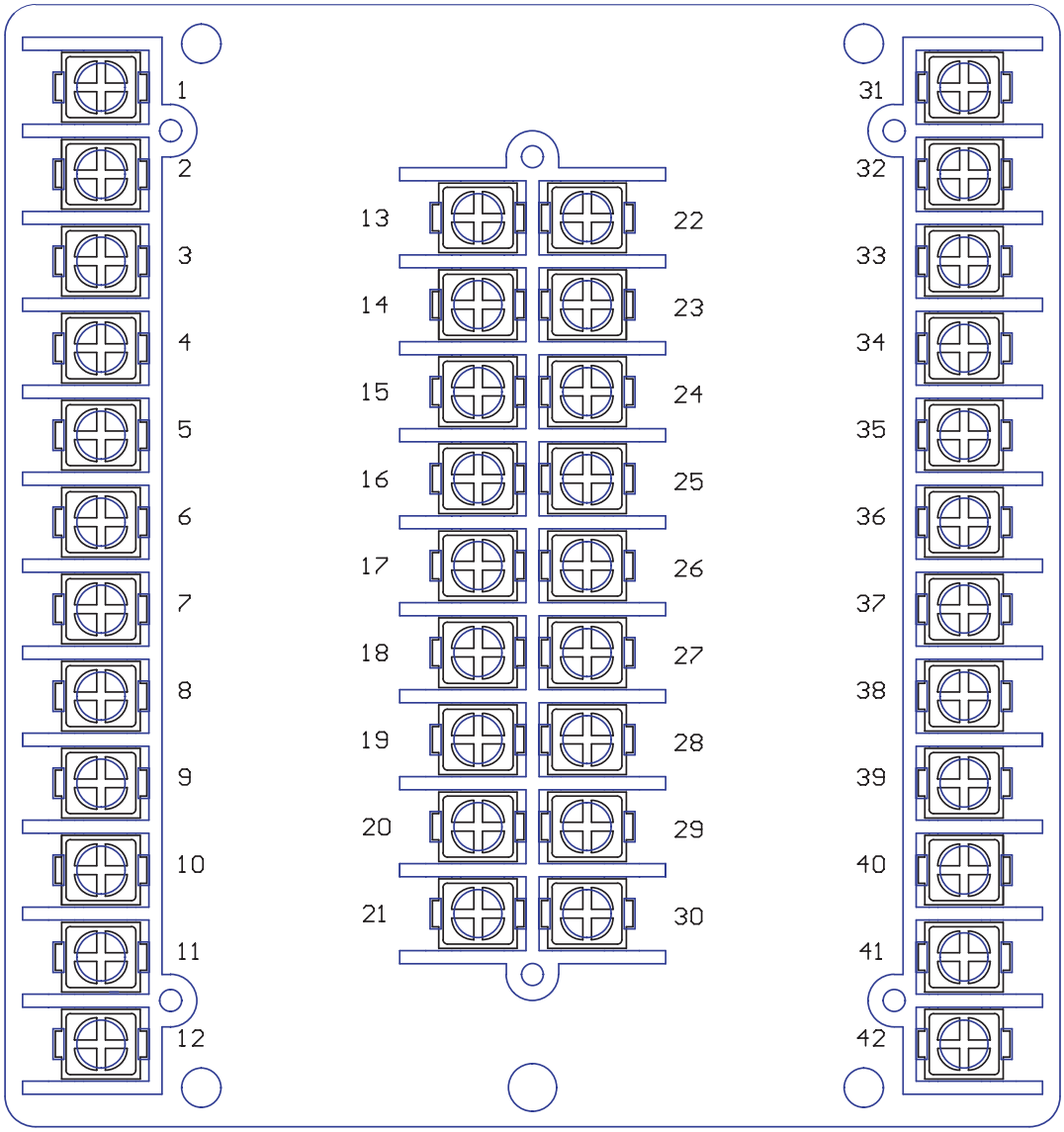
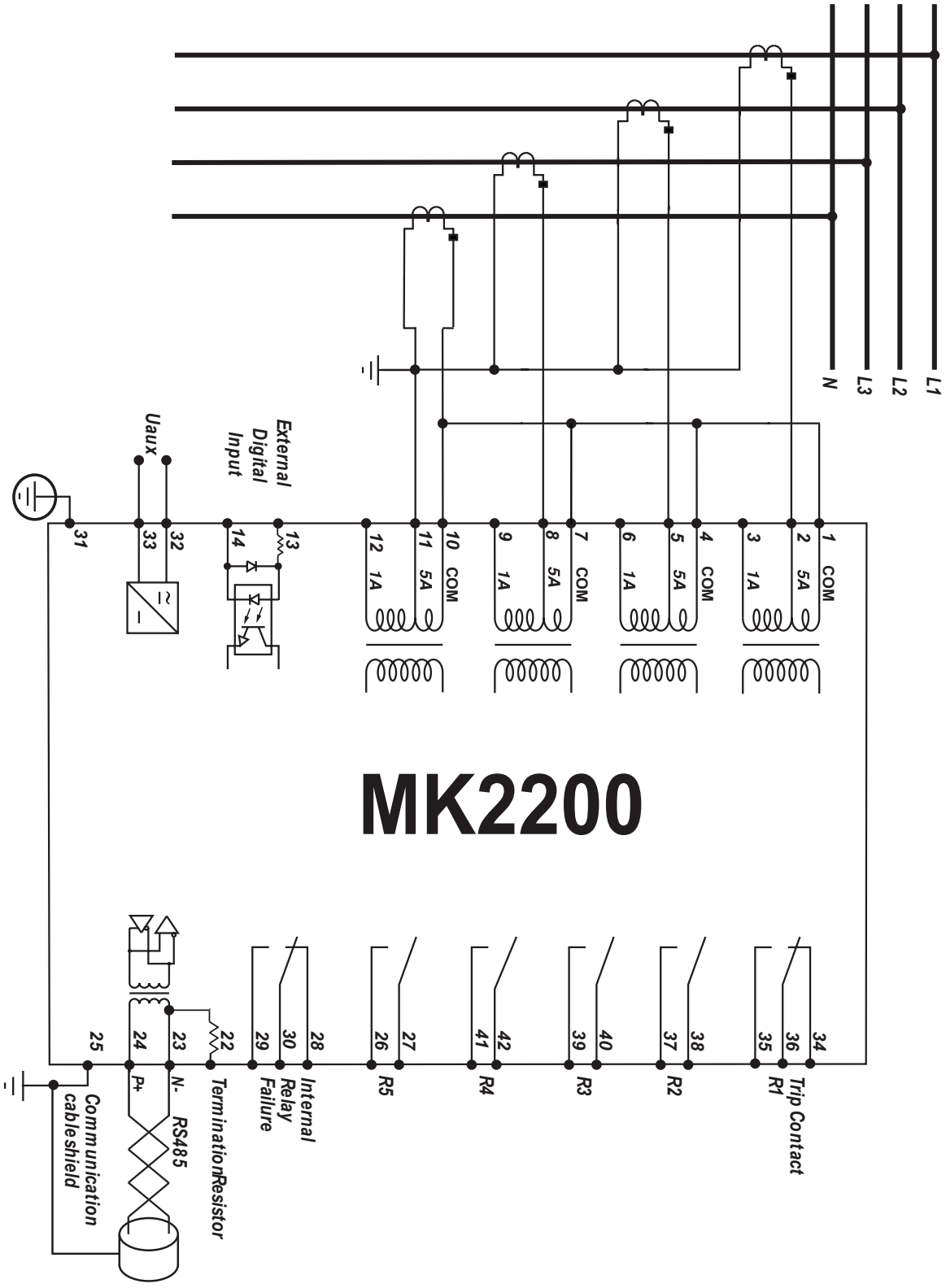


Figure 5.1: Rear view of MK2200

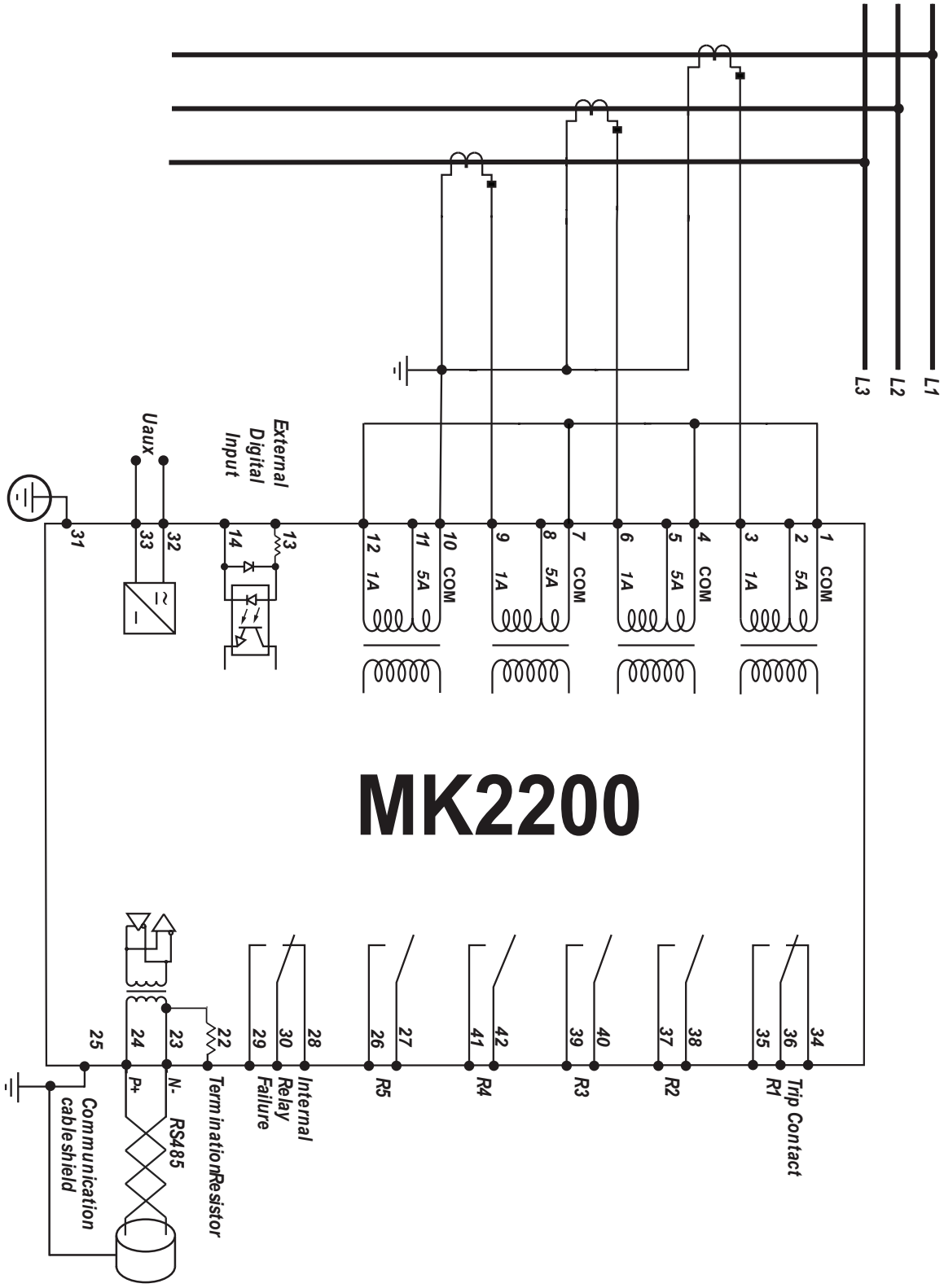
Connection terminal	Function Description
1	5A/ 1A common CT input for I_{L1}
2	5A CT input for I_{L1}
3	1A CT input for I_{L1}
4	5A/1 A common CT input for I_{L2}
5	5A CT input for I_{L2}
6	1A CT input for I_{L2}
7	5A/ 1A common CT input for I_{L3}
8	5A CT input for I_{L3}
9	1A CT input for I_{L3}
10	5A/ 1A common CT input for I_0
11	5A CT input for I_0
12	1A CT input for I_0
13	External digital input
14	External digital input
15 to 21	Not used
22	Termination resistor (for RS485)
23	RS485 negative terminal
24	RS485 positive terminal
25	Communication cable shield
26,27	Output contact R5
28	N.C. contact for IRF
29	N.O. contact for IRF
30	COMMON contact for IRF
31	Casing earth terminal
32	Auxiliary supply input (No polarity)
33	Auxiliary supply input (No polarity)
34	N.C. contact for tripping contact R1
35	N.O. contact for tripping contact R1
36	COMMON contact for contact R1
37,38	Output contact R2
39,40	Output contact R3
41,42	Output contact R4

5.2 Connection Diagrams

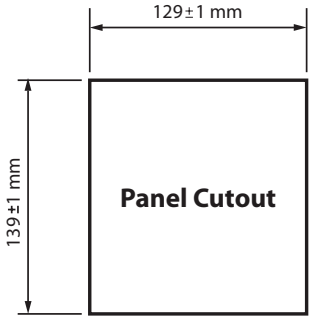
Example 1: Typical connection diagram

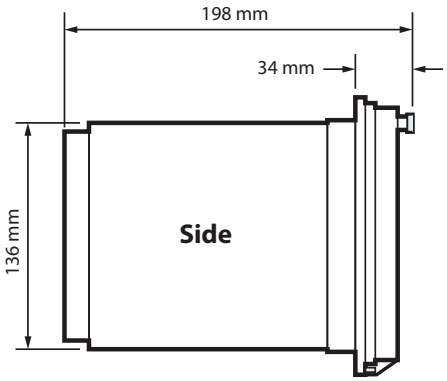


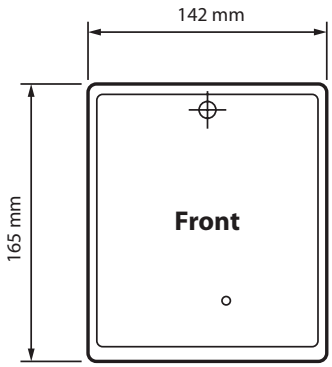
Example 2: Typical connection diagram



Chapter 6: Case Dimension







Chapter 7: Technical Data

Input

i)	Measuring inputs	
	Rated current I_n	1A or 5A
	Thermal withstand capability	4 x I_n continuous 25 x I_n for less than 10 sec 100 x I_n for less than 1 sec
	Burden	<0.3VA at I_n
ii)	Rated auxiliary supply voltage	
	Model MK2200-150D	24~150VDC
	Model MK2200-240AD	85~265VAC 110~340VDC
iii)	Power consumption	5~9W typical
iv)	External digital input	18~265VDC 85~265VAC

Output

i)	All contact	
	Rated voltage	250VAC
	Continuously carry	5A AC or DC
	Make and carry for 0.2sec	30A AC or DC
	Expected electrical life (min operation)	100,000 at max load
	Expected mechanical life (min operation)	5,000,000
	Operating time	Max. 15ms

Overcurrent element

i)	Low - set	
	Low-set setting I >	0.10 ~ 2.50 x I_n step 0.01
	Time multiplier	0.02 ~ 1.0 step 0.01
	Definite time setting	0 ~ 10.0 s step 0.01 10.0 ~ 100 s step 0.1 100 ~ 300 s step 1
	Reset ratio	95% typical
	IDMT curve and accuracy class (IEC255 -3)	Normal inverse (E5)
		Very inverse (E5)
		Extremely inverse (E7.5)
		Long-time inverse (E5)
ii)	High-set	
	High-set setting I >>	0.1 to 10 I_n step 0.05 10 to 40 I_n step 0.1
	Definite time setting	0 ~ 10.0 s step 0.01 10.0 ~ 100 s step 0.1 100 ~ 300 s step 1

Earth fault element

i)	Low-set	
	Low-set setting Io >	0.05 ~ 1.0 x I_n step 0.01
	Time multiplier	0.02 ~ 1.0 step 0.01
	Definite time setting	0 ~ 10.0 s step 0.01 10.0 ~ 100 s step 0.1 100 ~ 300 s step 1
	Reset ratio	95% typical
	IDMT curve and accuracy class (IEC255 -3)	Normal inverse (E5)
		Very inverse (E5)
		Extremely inverse (E7.5)
		Long -time inverse (E5)
ii)	High-set	
	High-set setting I >>	0.05 ~ 10.0 x I_n step 0.05
	Definite time setting	0 ~ 10.0 s step 0.01 10.0 ~ 100 s step 0.1 100 ~ 300 s step 1

Communication

i)	Hardware interface	Isolated RS485
ii)	Protocol	Modbus -RTU
iii)	Baud rate	300, 600, 1200, 2400, 4800, 9600, 19200

Chapter 8: Test and Standards

Insulation Tests

High voltage dielectric withstand test IEC60255-5	2 kVRMS, 1 minute
High voltage impulse test IEC60255-5	5 kV, 1,2/50 ðms

EMC Tests, Immunity

Electrostatic discharge immunity IEC 61000-4-2, IEC 60947-2	8 kV air discharge; 8 kV contact discharge
Radiated EM field immunity IEC 61000-4-3, IEC 60947-2	10 V/m 80 - 1000 MHz 1,4 – 2,0 GHz
Electrical Fast Transient immunity IEC 61000-4-4, IEC 60947-2	5/50 ns; 5 kHz 4 kV; AC input power port (U >= 100 VAC) 2 kV; signal ports
Surge transient immunity IEC 61000-4-5, IEC 60947-2	1,2/50 s 4 kV; AC input power port (line to line) 4 kV; AC input power port (line to earth) 1 kV; signal ports (line to line); Modbus - RTU 2 kV; signal ports (line to earth); Modbus - RTU
Damped oscillatory wave IEC 61000-4-12, IEC 60255-22-1, IEC 60694	1 MHz ringing wave (IEC60255-22-1) 0,5 s 100 kHz (IEC60694) 1,0 kV; AC input power port (line to line) 2,5 kV; AC input power port (line to earth) 1,0 kV; signal port (line to line); Modbus - RTU 2,5 kV; signal port (line to earth); Modbus - RTU
RF Conducted immunity IEC 61000-4-6, IEC 60947-2	0,15 – 80 MHz; 1 kHz – 80% AM 10 V; AC input power port
Current dips IEC 61000-4-11, IEC 60947-2	No tripping allowed at 0.9 times the current setting
Power supply interruptions and ripple EN 61000-4-11, IEC 60255-11	U_{NOM} – 100% (5 ms, 10 ms, 20 ms, 50ms, 100ms and 200 ms) 12 % ripple (AC component, full wave rectified, 100 Hz) on DC power supply
Power frequency magnetic field IEC 61000-4-8	30 A/m, 100 A/m, 300 A/m

Harmonic currents IEC 60947-2	50 Hz plus 150 Hz, 75 % Harmonic current 50 Hz plus 250 Hz, 50 % Harmonic current Step 1: Total RMS value = 0,9 times the current setting Step 2: Total RMS value = 2 times the current setting
LF signals IEC 61000-4-16	15 – 150 kHz, 30 V_{RMS}, 50 Hz continuous and 300 V_{RMS} short duration, mains power input

EMC Tests, Emission

Mains conducted disturbance voltage EN 55011 Group 1 Class B	Passed
Radiated EM Field emission CISPR 11 Group 1 Class B	Passed

Chapter 9: Appendix A

Binary to hexadecimal conversion table: -

Hexadecimal	Binary	Decimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
A	1010	10
B	1011	11
C	1100	12
D	1101	13
E	1110	14
F	1111	15

Chapter 10: Appendix B

Decimal to Hexadecimal Conversation

Decimal	Hexadecimal	Decimal	Hexadecimal	Decimal	Hexadecimal
1	1	44	2C	87	57
2	2	45	2D	88	58
3	3	46	2E	89	59
4	4	47	2F	90	5A
5	5	48	30	91	5B
6	6	49	31	92	5C
7	7	50	32	93	5D
8	8	51	33	94	5E
9	9	52	34	95	5F
10	A	53	35	96	60
11	B	54	36	97	61
12	C	55	37	98	62
13	D	56	38	99	63
14	E	57	39	100	64
15	F	58	3A	101	65
16	10	59	3B	102	66
17	11	60	3C	103	67
18	12	61	3D	104	68
19	13	62	3E	105	69
20	14	63	3F	106	6A
21	15	64	40	107	6B
22	16	65	41	108	6C
23	17	66	42	109	6D
24	18	67	43	110	6E
25	19	68	44	111	6F
26	1A	69	45	112	70
27	1B	70	46	113	71
28	1C	71	47	114	72
29	1D	72	48	115	73
30	1E	73	49	116	74
31	1F	74	4A	117	75
32	20	75	4B	118	76
33	21	76	4C	119	77
34	22	77	4D	120	78
35	23	78	4E	121	79
36	24	79	4F	122	7A
37	25	80	50	123	7B
38	26	81	51	124	7C
39	27	82	52	125	7D
40	28	83	53	126	7E
41	29	84	54	127	7F
42	2A	85	55		
43	2B	86	56		